U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-190-314

B-W FOOTWEAR COMPANY, INC.
WEBSTER, MASSACHUSETTS

JULY 1976

I. TOXICITY DETERMINATION

It has been determined that "Sprayers", "Adhesive Applicators", "Mold Operators", "Stainers", "Shoe Sole Surface Treaters", and "Shoe Upper Cleansers", are exposed to toxic or potentially toxic concentrations of mixtures of vapors (hexane, acetone, ethyl acetate, methyl ethyl ketone, isopropanol, ethanol, methyl isobutyl ketone, toluene, and butyl acetate).

This determination is based on results of an environmental evaluation conducted on January 7, 1976 and a medical evaluation conducted on April 28, 1976.

Recommendations

Recommendations to correct existing conditions are incorporated within this report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) B-W Footwear Company, Inc., Webster, Massachusetts
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region I
d) NIOSH - Region I

For the purpose of informing the approximately twenty (20) "affected" employees, the employer shall promptly "post" the Determination Report for a period of 30 calendar days in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the Executive Safety Director (for B-W Footwear) regarding employees' exposure to organic vapors eminating from materials used in "cementing", "spraying", and "staining" of shoes. The request was submitted because there were so many chemicals involved and the Executive Safety Director felt that it was necessary to determine if a health hazard existed.

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

B-W Footwear is engaged in the production of shoes; most of the shoes are produced from man-made materials.

The entire process (from cutting of materials to packaging) is conducted in one large workroom with a high ceiling. The production work force (311), comprised mainly of women, is spread over two shifts with the majority on the first shift.

There are no walls separating work areas; work areas are identified by the operation conducted at that location. Three of the areas have a general classification of "compo area", "stock-fit area", and "packaging."

The following operations were conducted in these work areas:

1) Applying an adhesive to the bottom of shoes. This operation is conducted by six employees; three in the "Compo" area and three in the stock-fit area. The operation involves placing the un-soled shoe on a shoe-shaped metal object which is then activated (by foot) to rotate. As it rotates, an adhesive is spread by hand (without the use of gloves) when the machine does not apply it properly. Excess adhesive is removed from the hand by utilizing acetone. The cement (adhesive) contains methyl ethyl ketone, ethyl acetate, and acetone. This operation is conducted without local exhaust.

2) Finger washing is conducted in the "Compo" area by one employee. This consists of cleaning shoes with a cloth soaked in a cleaning solvent (MEK and acetone). This operation is conducted without local exhaust.

3) Staining of the upper part of the shoe is conducted by spraying them in small locally exhausted hoods. Constituents contained in this spraying operation include ketones, acetates, alcohols, and toluene. The spraying is conducted by two employees.

4) Also conducted in the "Compo" area is a PVC molding operation. Six shoe-sole producing molding machines are operated by three employees. Polyvinyl Chloride (PVC), in the form of pellets, is the material used to produce the shoe soles.

5) In the stock-fit area, two employees stain PVC shoe sole by hand. Materials contained in the stain include ketones and toluene. No local exhaust is provided in this work area. Portable (air circulating) fans are available to aid in dispersing any vapor which may emanate during the operation.

6) Adjacent to this, two employees treat PVC soles with MEK so that they will adhere to the upper portion of the shoe better. No local exhaust is provided at this location. The last mentioned four employees were required to have a respirator (equipped with a cartridge for organic vapors) on their person; however the respirators were observed not to be worn.

7) One employee cleaned off shoe uppers near the packaging area with a solvent after they had been stained; the purpose of this was to obtain an alligator effect. The solvent contained ketones, toluene, alcohol, acetates, and an aliphatic hydrocarbon.

A spraying operation in an adjacent area (packing area) was also evaluated although the packing area was not included in thr request. A stain and a lacquer type finish were applied to finished shoes by spraying them in a small locally exhausted hood. This operation was conducted by two employees.

B. Evaluation Progress

Employees' exposure to organic vapors in the areas mentioned above were evaluated by collecting breathing zone samples on charcoal tubes on January 6, 1976. As part of the evaluation, ventilation measurements of existing exhaust systems were made and medical questionnaires were administered to employees performing the described operations. On April 28, 1976 a medical evaluation was conducted by John Lewis,M.D.

C. Evaluation Methods

1. Environmental

Each employee working with the organic materials (as described above) was included in the sampling protocol. Breathing zone samples were collected on charcoal tubes at approximately 50 cubic centimeters per minute. A limited number of short term samples also were collected (at 1 liter per minute) in those work areas where it was deemed necessary. These samples were analyzed by gas chromatography.

The ventilation measurements were made with an Alnor Velometer, Senior. Also, the environmental evaluation was supplemented by (the industrial hygienists) administering non-directed medical questionnaires.

2. Medical

The medical evaluation was conducted as a result of information obtained from the non-directed questionnaires. This consisted of the medical officer administering a directed medical questionnaire to fifteen of the eighteen employees whose breathing zone concentrations had been previously determined; three of the employees were absent because of

non-work related reasons. The questionnaires included questions to detect peripheral neuropathy. Employees also were asked about any skin problems they may have experienced at any time; an examination of the skin was performed if the employee reported experiencing such problems at the time.

D. Evaluation Criteria

1. Environmental Criteria

The primary environmental evaluation criteria considered in this report are (1) NIOSH criteria documents recommending occupational health standards (2) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) and supporting documentation and (3) Federal Occupational Health Standards promulgated by the U.S. Department of Labor (29 CFR Part 1910.1000). Only the recommended standard, TLV, or Federal Standard considered most applicable is listed along with its source.

	Time Weighted Average (TWA) Conc. in parts per million (ppm)
Hexane[a]	100
Acetone[a]	1000
Ethyl Acetate[a]	400
Methyl Ethyl Ketone[a]	200
Isopropanol[b] - skin	400*
Ethanol[a]	1000
Methyl Isobutyl Ketone[a] - skin	100
Toluene[c]	100**
Butyl Acetate[a]	150

a) ACGIH Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1975.

b) NIOSH Criteria for a Recommended Standard...Occupational Exposure to Isopropyl Alcohol, 1976.

c) NIOSH Criteria for a Recommended Standard...Occupational Exposure to Toluene, 1973.

* 400 is to be determined as a TWA concentration for up to a 10-hour work day, with a ceiling value of 800 ppm for any 15 minute period.

** 100 is to be determined as a TWA concentration for an 8-hour work day, with a ceiling value of 200 ppm for any 10 minute period.

In addition to the criteria listed above, a Threshold Limit Value for mixtures also was used. Such a Threshold Limit Value is used when two or more hazardous substances, present at the same time, affect the same site (within the human body) in a similar way. The Threshold Limit Value is calculated as described in Appendix "C" of the TLV Booklet and is as follows:

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots \frac{C_n}{T_n}$$

If the sum of the individual fractions exceed unity, then the threshold limit value for the mixture has been exceeded. In the above formula, C_1 is the measured concentration for one of the substances in the mixture and T_1 is the corresponding TLV.

The following criteria, taken from the ACGIH Industrial Ventilation Manual, was used in evaluation of the local exhaust systems:

RANGE OF CAPTURE VELOCITIES

Condition of Dispersion of Contaminant	Examples	Capture Velocity, fpm
Released with practically no velocity into quiet air.	Evaporation from tanks; degreasing, etc.	50-100
Released at low velocity into moderately still air.	Spray booths; intermittent container filling; low speed conveyor transfers; welding; plating; pickling	100-200
Active generation into zone of rapid air motion	Spray painting in shallow booths; barrel filling; conveyor loading; crushers	200-500
Released at high initial velocity into zone of very rapid air motion.	Grinding; abrasive blasting, tumbling	500-2000

In each category above, a range of capture velocity is shown. The proper choice of values depends on several factors:

Lower End of Range	Upper End of Range
1. Room air currents minimal or favorable to capture.	1. Disturbing room air currents.
2. Contaminants of low toxicity or of nuisance value only.	2. Contaminants of high toxicity.
3. Intermittent, low production.	3. High production, heavy use.
4. Large hood—large air mass in motion.	4. Small hood—local control only.

2. Physiological Effects

Hexane - At elevated concentrations, hexane may cause narcosis. At concentrations somewhat lower, it may produce nausea, headache, eye and throat irritation, and dizziness. Repeated exposures to low concentrations may produce peripheral neuropathy.

Acetone - Acetone has a low order of toxicity from inhalation but it does possess the property of being able to defat the skin upon contact. At extremely high concentrations it does have an anesthetic effect.

Ethyl Acetate - Prolonged and excessive exposure to this agent may result in dermatitis, mucous membrane irritation and respiratory tract irritation and narcosis.

Methyl Ethyl Ketone (MEK) - Prolonged exposure to MEK may result in mucous membrane irritation, nausea, vomiting, dermatitis, headache and paresthesias.

Isopropyl Alcohol - Isopropyl alcohol is only mildly irritating to the eyes, nose, and throat. At high concentrations it may cause narcosis.

Ethanol - Ethanol vapor is irritating to eyes and upper respiratory tract even at low concentrations; other symptoms include headaches, sensation of heat, intra ocular tension, stupor, fatigue, and a great need for sleep.

Methyl Isobutyl Ketone (MIBK) - MIBK is primarily an irritant but also possesses a narcotic effect. Acute intoxication may result in mucous membrane irritation, nausea, vomiting, dermatitis, headache, and paresthesias.

Toluene - Prolonged excessive exposure to this agent may acutely cause headache, weakness, fatigue, unconsciousness, loss of coordination, nausea vomiting, anorexia, acute dermatitis and irritation of skin and mucous membranes.

N-Butyl Acetate - N-butyl acetate is primarily an irritant but also possesses some narcotic effect. Symptoms of intoxication include irritation of mucous membranes followed by incoordination, fatigue, weight loss, and narcosis.

E. Evaluation Results and Discussion

Breathing zone concentrations for various chemicals are shown in Table 1 for those job classifications listed in said table. MEK concentrations measured in Adhesive Applicators' respective breathing zones are considerably in excess of those values considered as safe exposure levels. Individual concentrations measured in other employees respective breathing zones do not lend themselves to such a definite decision. However, using the threshhold limit value for mixtures, sixteen of the twenty-one concentrations reported (in Table I) exceed the TLV and two are at 80% of the permissible level. Also, the results of the medical questionnaires indicate that a number of employees had experienced light headedness, irritation of the eyes, nose and throat, dry hands, and in a few instances, nosebleeds. Because of such findings, and the fact that the signs/symptoms reported to the medical officer (see Table II) are consistent with exposure to such agents, it was determined that all employees included in the study were exposed to toxic or potentially toxic concentrations of organic vapors.

Although only those employees who actually used the materials in question were included in the study, there were several more employees in adjacent areas who may have been exposed to similar concentrations. There are no walls within the workroom and work areas are separated by distance only.

An attempt to determine if PVC molders were exposed to vinyl chloride was made. However, due to so many other organic air contaminants it was impossible to determine if vinyl chloride was present in any of the samples.

Considering the velocities at which the materials (air contaminants) are released and the size of the local exhaust hoods, it has been determined that the capture velocities for the hood in the "Compo" area and the one in the packing area are inadequate.

V. RECOMMENDATIONS

1. Provide a local exhaust system(s) for the following operations: adhesive application, finger washing, shoe sole surface treating (with MEK), shoe sole staining (by hand), and washing (of shoe uppers for grain effect). The minimum acceptable capture velocity in each case is 100 feet per minute.

2. Upgrade the existing local exhaust hoods such that the minimum capture velocity is 500 feet per minute in each case.

3. Provide appropriate hand protection (gloves) for those employees who come in contact with the organic materials in question. In order to avoid creating another problem, cotten liners also should be provided and changed regularly.

4. Determine if PVC molders are exposed to vinyl chloride after recommendations 1 and 2 have been instituted.

VI. BIBLIOGRAPHY

1. NIOSH: Criteria for A Recommended Standard...Occupational Exposure to Toluene, 1973.

2. NIOSH: Criteria for A Recommended Standard...Occupational Exposure to Isopropyl Alcohol, 1976.

3. ACGIH: Industrial Ventilation, A Manual of Recommended Practices, 12th Ed., 1972.

4. ACGIH: Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1975 and Supporting Documentation.

5. Federal Register, June 27, 1974, Vol. 39, No. 125, Title 29, Chapter XVIII, 1910, Sub part G.

6. Patty, F., Industrial Hygiene and Toxicology, Vol. II, 1967.

VII. AUTHORSHIP AND ACKNOWLEDGMENTS

Report Prepared By: Raymond O. Rivera
Industrial Hygienist
Cincinnati, Ohio

Originating Office: Jerome P. Flesch, Acting Chief
Hazard Evaluation and
Technical Assistance Branch
Cincinnati, Ohio

Acknowledgments

Medical Evaluation: John Lewis, M.D.
NIOSH Medical Officer assigned to
Massachusetts Department of
Labor and Industries
Boston, Massachusetts

Environmental Evaluation: Beth S. B. Levy
Industrial Hygienist

TABLE I

Breathing Zone Concentrations Measured at B-W Footwear Company
Webster, Massachusetts

January 7, 1976

Time Weighted Average Concentrations in Parts Per Million

Sample Number	Job Classification	Time	Hexane	Acetone	Ethyl Acetate	Methyl Ethyl Ketone	Isopropanol	Ethanol	Methyl Isobutyl Ketone	Toluene	Butyl Acetate	Ratio of Concentration to TLV**	Comments
24	Finger Washer (A)	1408-1421	-	202.1	-	153.3	-	-	2.3	28.4	-	1.3	Short term sample, "Compo" Dept
5 & 41	Finger Washer (A)	0724-1153											
		1237-1510	-	252.1	-	123.0	-	-	2.2	26.7	-	1.2	
4 & 35	Stain Shoes (B) (spraying)	0726-1153											
		1237-1510	21.9	73.2	1.6	117.6	<0.01	N.D.	N.D.	18.0	<0.01	1.1	Compo Dept.
3 & 33	Stain Shoes (C) (spraying)	0723-1153											
		1238-1509	21.5	74.1	1.4	58.5	<0.01	N.D.	N.D.	18.1	<0.01	0.8	Compo Dept.
11 & 42	Mold Operator (D) (PVC injection mold)	0811-1156											
		1218-1513	34.01	54.1	3.2	52.3	N.D.	12.8	N.D.	33.6	0.4	1.0	Compo Dept.
9 & 36	Mold Operator (E) (PVC injection mold)	0808-1151											
		1242-1512	31.3	150.3	1.8	111.8	N.D.	9.6	0.2	24.1	0.8	1.3	Compo Dept.
7 & 44	Adhesive Applicator (H)	0730-1155											
		1233-1510	21.9	528.4*	0.7	306.0	N.D.	N.D.	N.D.	20.1	N.D.	2.5	Compo Dept.
8 & 39	Adhesive Applicator (I)	0730-1155											
		1235-1510	18.4	423.0*	N.D.	221.7	N.D.	N.D.	N.D.	15.8	N.D.	1.9	Compo Dept.
25	Adhesive Applicator (J)	1425-1440	24.1	266.1*	1.9	287.4	2.4	N.D.	N.D.	23.6	0.6	2.2	Short term sample, Compo Dept.
6 & 32		0728-1154											
		1235-1510	18.7	495.3*	N.D.	274.2	N.D.	N.D.	N.D.	17.5	N.D.	2.2	Compo Dept.
21 & 26	Adhesive Applicator (F)	0745-1249											
		1250-1442	19.7	195.2	1.6	149.1	N.D.	N.D.	N.D.	17.8	0.9	1.3	Stock Fitting Dept., includes 1/2 hour lunch
20 & 27	Adhesive Applicator (G)	0743-1246											
		1248-1442	20.0	277.2	1.7	174.1	N.D.	N.D.	N.D.	17.9	0.9	1.5	Stock Fitting Dept., includes 1/2 hour lunch

TABLE I (contd)

(B-W Footwear Company, Webster, Massachusetts)

Sample Number	Job Classification	Time	Hexane	Acetone	Ethyl Acetate	Methyl Ethyl Ketone	Isopro-panol	Ethanol	Methyl Isobutyl Ketone	Toluene	Butyl Acetate	Ratio of Concentration to TLV **	Comments
2,19,29	Adhesive Applicator (K)	0800-0953 0953-1245 1245-1442	21.2[a]	153.7	0.9[a]	133.7	N.D.	N.D.	1.7[b]	17.3	0.4[a]	1.2	Stock Fitting Dept., applied adhesive from 0800-0953; prepared sole for adhesive from 0953-1245, back to applying adhesive 1245-1442; includes 1/2 hour lunch
1	Shoe Sole Surface Treater (L)	0737-0900	-	75.2	-	123.3	-	-	1.0	10.2	-	0.8	Stock Fitting; switch to a different job at 0900
16 & 28	Shoe Sole Surface Treater (M)	0739-1232 1232-1451	-	N.D.	-	35.3	-	-	0.4	7.0	-	0.3	Stock Fitting Dept., includes 1/2 hour lunch
18 & 30	Shoe Sole Stainer (N) (by hand)	0736-1240 1240-1455	-	37.6	-	73.7	-	-	6.1	16.9	-	0.6	Stock Fitting Dept., includes 1/2 hour lunch
45	Shoe Sole Stainer (O)	1445-1457	-	76.5	-	229.96	-	-	21.0	54.2	-	2.0	Stock Fitting Dept. Short term sample
17 & 31	(by hand)	0735-1238 1238-1455	-	N.D.	-	38.4	-	-	6.3	13.4	-	0.4	Stock Fitting Dept., includes 1/2 hour lunch
22 & 40	Washer (P) (for grain effect)	0748-1251 1251-1512	47.6	19.9	8.4	25.1	N.D.	N.D.	N.D.	48.4	N.D.	1.1	Sole Leather Room, includes 1/2 hour lunch
14 & 34	Staining Shoes (Q) (spraying)	0755-1150 1243-1515	37.5	50.7	8.3	56.5	N.D.	36.8	1.8	36.5	N.D.	1.1	Packing Area
13 & 38	Finisher (R) (spraying lacquer type finish)	0753-1157 1244-1515	30.3	56.4	3.4	44.2	N.D.	<0.01	10.8	40.7	0.2	1.1	Packing Area

- no analysis for this chemical
N.D. - none detected
* - minimum concentration; charcoal tube saturated
a - conc. is for samples 2 & 29 only; 230 minutes
b - conc. is for sample 19 only; 172 minutes
**Permissible exposure is anything <1.0; TLV is 1.0

TABLE II

Results of Medical Interviews
Signs and Symptoms Experienced in the Past

B-W Footwear Company, Inc.
Webster, Massachusetts

April 28, 1976

Signs/Symptoms	No. Workers with Symptoms	% with Symptoms
Dry and/or cracked skin of hands	12*	80
Nasal stuffiness	11	73
Unusual tiredness	10	67
Nosebleed	5	33
Headache	5	33
Lightheadedness	5	33
Difficulty with balance	4	27
Difficulty breathing	3	20
Cough	3	20
Painful or cramping muscles	3	20

No symptoms of peripheral neuropathy were observed.

*Confirmed by physical examination.

Note: Total Percentage is greater than 100% since most persons had more than one complaint.